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Determinants of knowing HIV status among Nigerian couples: A multilevel modelling approach

Key works: HIV testing demand, uptake, ARV-based prevention, multi-level modelling, Nigeria.

Abstract

In this paper we analyse the determinants of HIV testing among Nigerian couples using Demographic and Health Survey (DHS) data set (2008). This study is motivated by the fact that although there is a strong willingness from the Nigerian Government to examine new HIV preventions approaches such as Pre-Exposure Prophylaxis for HIV (PrEP) and Treatment as Prevention (TasP) for HIV sero-discordant couples, the implementation of such policies would require to know the HIV status of each partner in the couple. This is far to be achieved in the Nigerian context since in Nigeria only 6% of couples know thir HIV status. In order to highlight the policies that are needed to increase HIV testing uptake, we use a three-level random intercept logistic model to separately explore the determinants of knowing HIV status among female and male partners. The use of the multilevel modelling allows including the unobserved heterogeneity at the village and state level that may affect HIV testing behaviours. Our results indicate that education, wealth, stigma, HIV knowledge and perceived risk are predictors of HIV testing among both partners while routine testing appears to be very effective to increase HIV testing among women. The introduction of financial incentives as well as an increase in routine testing and home-based testing may be required prior to implement new HIV prevention policies among discordant couples.

Key terms: HIV testing, multilevel modelling, Nigeria.

1. INTRODUCTION

With an HIV prevalence of 4.1% in 2010, Nigeria has almost 3.5 million people living with HIV/AIDS (PLWH/A) and ranks third among the countries with the highest HIV burden in the world (National Agency for the Control of AIDS, 2012). Despite political commitment to address HIV/AIDS (HIV hereafter) and scale up existing proven interventions such as the prevention of mother to child transmission (PMTCT) and anti-retroviral therapy (ART), an estimated 388,864 new infections occurred in 2011 (National Agency for the Control of AIDS, 2012). Therefore, it is urgent to implement more effective strategies to stem the number of new infections.

Recent trials have found a strong impact of antiretroviral (ARV)-based prevention of HIV transmission, as early initiation of HIV treatment, termed 'treatment as prevention' (TasP) (Attia, Egger, Müller, Zwahlen, & Low, 2009; Cohen et al., 2011; Donnell et al., 2010) and acquisition, as pre-exposure prophylaxis (PreP) (Baeten et al., 2012; Karim et al., 2010; Thigpen et al., 2012; Van Damme et al., 2012). Nigeria is currently examining the different options for PrEP and TasP delivery among discordant couples. However, with only 15% of married Nigerian adults knowing their HIV status (Demographic and Health Survey, 2008), HIV testing remains a critical barrier to effective implementation of ARV-based prevention. Beyond the importance of testing in the context of programme introduction, HIV testing has some strong policy implications through its positive effects on sexual behaviours (Weinhardt, Carey, Johnson, & Bickham, 1999). Those who are diagnosed HIV negative can adopt behaviours to protect themselves from a future infection while those diagnosed HIV positive can seek treatment and adopt behaviours to protect others (sexual partners and children). This study aims to understand factors affecting the uptake of HIV testing among married Nigerian couples.

Several studies have analysed the barriers of HIV testing at the individual level (Bwambale, Ssali, Byaruhanga, Kalyango, & Karamagi, 2008; Cartoux et al., 1998; Castle, 2003; Cremin, Cauchemez, Garnett, & Gregson, 2012; Gage & Ali, 2005; Remien et al., 2009). Main findings are that patterns of HIV testing in Sub-Saharan Africa are low (less than 30%) and vary a lot depending on the context (from 2% to 27%). Most important predictors of HIV testing at the individual level highlighted by qualitative and quantitative methods are socio-economic characteristics, gender-related barriers, education, perceived risk, spousal communication, awareness of treatment, HIV knowledge, characteristics of test sites (distance, quality of test) and stigma.

This paper contributes to the literature in three ways. Firstly, we analyse the samples of wives and husbands separately to quantitatively explore gender specific barriers to HIV testing, thus looking beyond individual level determinants as done in the literature to date. Secondly, to the best of our knowledge, this is the first study to analyse the determinants of HIV testing in Nigeria based on a nationally representative sample. Thirdly, to take into account the fact that similar HIV testing behaviours are likely to be observed among couples from the same village and to correct for the presence of unobserved heterogeneity, the study uses a multilevel modelling approach by estimating a three-level random intercept logistic model to include the effect of unobserved characteristics of village and state of the respondent on the likelihood of being tested, which is novel in the estimates of determinants of testing. This approach provides critical evidence on

current barriers to testing and suggests policies which could encourage wider participation in HIV testing.

2. DATA AND VARIABLE SPECIFICATIONS

2.1 DATA

The 2008 Nigeria Demographic and Health Survey (DHS) is used to analyse the determinants of knowing ones HIV status to inform the introduction of ARV based prevention for discordant couples. The dependent variable is coded 1 if the individual has ever been tested and received their test result. The analysis is conducted at the individual level for women and men separately and focuses on a sample of 8731 couples[1]. The DHS consists of a randomly selected, representative sample of couples at the national level. Data on HIV prevalence were obtained from the National HIV/AIDS and Reproductive Health Survey (NARHS) conducted in 2007 by the Ministry of Health (MoH) of Nigeria.

2.2 DETERMINANTS OF HIV TESTING IN THE LITERATURE AND VARIABLE SPECIFICATION

Following Weiser et al. (2006) the determinants of testing were classified into six categories: *socio-economic factors*, *HIV-related stigma*, *HIV knowledge, routine testing*, and *health status*. We further add *perceived risk* as suggested by Maman et al. (Maman, Mbwambo, Hogan, Kilonzo, & Sweat, 2001). Note that some variables span categories.

Socio-economic factors

Socio-economic characteristics of the respondent and of his or her partner were included in the estimates.

Ethnicity and *religion* may capture behavioural and social factors such as the perception of HIV, perceived risk, the acceptance of testing and sexual practises. *Education* is also expected to be an important determinant of the likelihood of being tested (Fylkesnes & Siziya, 2004). The degree of risk behaviour and sexual practises may vary depending on the age of the individual.

[1] Note that the data set actually contains 8731 wives aged between 15 and 49 years old but only 7521 husbands since 22% of men are polygamous and have on average 1.16 wives.

Educated people are more likely to invest in their health capital (Grossman, 1972) and are consequently more likely to see the benefits of knowing their HIV status. *Labour status*, on one hand, is found to be a reason for desiring an HIV test since some companies would require it for employment (Ministry of Health of Nigeria, 2008) but on the other hand, workers also experience a greater opportunity cost of time, which can prevent them from going to the testing centre. The degree of risk behaviour and sexual practises may vary depending on the *age* of the individual. However, since there are many factors associated both with age and HIV testing such as self-perceived risk, health status and perceived benefits of testing, the effect of age is unknown. *Age-squared* is included to incorporate potential non-linearity as highlighted previously in the literature (Cremin et al., 2012).

The effect of polygamy and women's bargaining power on HIV testing was included in the analysis. Two bargaining power indexes were created; one capturing the decision-power of the wife (*bargaining power)* in the union and another one measuring her *sexual bargaining power*, where the weights used to construct the indicators are derived from the first dimension of a Multiple Correspondence Analysis (MCA) (see Appendix 1). Bargaining power indexes are found to be negatively correlated to *polygamy*, which is explained by the fact that polygamous husband's threat point utility[2] is still high in the event of divorce.

Household *wealth* is proxied by a wealth index computed with a MCA based on asset ownership[3] and housing quality, weights obtained are presented in Appendix 1. In order to take into account that the likelihood of owning assets is greater for larger households, the *household size* is also added as control.

Further, *partner's age*, *partner's labour status* and *partner's education level* are included.

HIV-related stigma

In the literature stigma[4] appears to be a very strong barrier to HIV testing (Kalichman & Simbayi, 2003; J.M. Turan et al., 2011; Janet M. Turan et al., 2012). People who stigmatise PLWA are found to be less likely to be tested, and people may not be willing to know their HIV status if they are afraid of being discriminated against by their partner. Therefore, we incorporate *stigma* both as an

[2] Note that the threat point utility refers to the utility of each spouse in the event of divorce (Manser & Brown, 1980; McElroy & Horney, 1981) and according to the cooperative Nash bargaining model (Nash, 1950) all factors affecting a spouse's well being outside the union determine his or her bargaining power inside the union.

[3] Note that the wealth index created is poorly correlated to the variable capturing if the persons often listen to the radio (correlation coefficient=0.35).

[4] Stigma is defined as an undesirable or discrediting attribute that an individual possesses, thus reducing that individual's status in the eyes of society (Goffman, 1963)

index of the individual's attitudes and the partner's attitude (*partner's stigma*). HIV-related stigma is measured by a seven item-index capturing stigma and discrimination towards PLWH/A, where weights were derived from a MCA and are presented in Appendix 2.

HIV knowledge

The relationship between HIV knowledge and HIV testing is *a priori* unclear. Individuals who have a good understanding of HIV prevention and transmission could be less likely to adopt risky behaviours and thus would be less willing to know their HIV status. However, people who over-estimate the likelihood of getting infected through their poor HIV knowledge would probably have a higher likelihood of being tested. *HIV knowledge* score is based on eight questions measuring the knowledge of HIV transmission and prevention as shown in Appendix 3. The score was obtained by giving one point to respondents who knew the correct response, 0.5 to those who did not know what the correct response was and 0 to those who answered the incorrect response. A variable that indicates if the respondent *heard of ART* to help infected people to live longer is also included and is expected to positively affect HIV testing. Additionally, a variable capturing whether or not the individual often listens to *radio* is used as proxy for exposure to behaviour change communication (Farr, Witte, Jarato, & Menard, 2005; Karlyn, 2001).

Routine testing

According to UNAIDS/WHO Policy Statement on HIV Testing (2004), health providers should offer routine testing to patients presenting with a sexual transmitted infection (STI), to pregnant women, as well as to all patients consulting in high prevalence areas. Thus, variables capturing the presence of an *STI* during the last year, a *birth in the last three years* as well as *state level HIV prevalence* are added in the model.[5] Some information available in the DHS data set that may also influence the frequency of health care use was included. For instance, for 27% of women surveyed the *absence of a female health worker* in the facility is a main concern. Assuming that those women are less likely to seek care, it is expected that they are less likely to have been tested (Remien et al., 2009). *Health insurance* status is also likely to have a positive effect on the likelihood of having been tested since insured persons are found to have a greater demand for preventive and curative health care than their uninsured counterparts in low-income settings (Jowett, Contoyannis, & Vinh, 2003; Jütting, 2004; Msuya, Jütting, & Asfaw, 2007). However, because health insurance coverage is extremely low in Nigeria (3%), people who are covered may have specific characteristics that are not captured

[5] State level HIV prevalence are hypothesised to both contribute to the likelihood of being offered testing following guidelines and self-perceived risk of being HIV positive.

in the model. Finally, the location of the household is included as households located in *rural* areas are less likely to have access to a health facility.

Health status

People with poor health, measured here by the body mass index (*BMI*) (Bailey & Ferro-Luzzi, 1995), are more likely to attend health facilities and receive Provider Initiated Testing and Counselling (PITC). Moreover, one may be more willing to be tested when health status deteriorates (Shuter, Alpert, DeShaw, Greenberg, & Klein, 1997). Note that although the two channels may indicate a negative relationship between health status and HIV testing, health status could be positively correlated if one considers health as a result of investment in human capital, then people with a better health status are also more likely to be high investors in their health and seek out testing.[6]

Perceived risk

Finally, the perceived risk is included in the model (Maman et al., 2001). This is operationalised by knowing *partner has been tested, marital duration*, the *number of lifetime partners*, the fact to *know someone living with HIV* or who has died which is shown to be a cue to action that could activate the willingness to accept to be tested (de Paoli, Manongi, and Klepp (2004).

3. DESCRIPTIVE STATISTICS

In Nigeria in 2008, HIV testing was low. On average 14% and 15% of married men and women had been tested, respectively, while only 6% of couples (i.e. both partners) had been tested. This translates into 37% of tested men and 43% of tested women had tested partners. Prevalence of testing may also be attributable to state characteristics as shown in Figure 1, such as HIV prevalence.

Insert figure 1

DHS data set also shows that 44% and 40% of the HIV tests were received during the last 12 months among men and women, respectively. The share of voluntary counselling and testing

[6] Note that adult anthropometric measures are only available for women.

(VCT) is slightly greater than the share of PITC in the sub-sample of men. Indeed, among the men who were tested, the share of VCT and PITC were respectively 52% and 48%. However, the opposite is observed in the sub-sample of women where VCT only represents 16% of tests and 84% are PITC tests; this is explained by the fact that HIV testing is often offered by the health provider to women demanding antenatal care. Among those who were tested, 10% did not receive their test result in the sub-sample of wives and 7% among husbands.

Insert table 1

4. MODEL

Testing may be affected by unobserved state and village level factors. In a federal system such as Nigeria's, with high level of decentralization, one might think of variations in health policies and priorities at the state level. At the village level, the health service characteristics, such as quality, confidentiality and distance, will affect testing as well as local social and behavioural factors affected by stigma and local culture. Under such circumstances, the assumption of conditional independence of responses of individuals living in the same village given the covariates may be violated. To relax this assumption a nested logistic model with two random intercepts[7], one at the village and one at the state level, is used. The model, which is a simple Generalized Linear Mixed model with fixed effects and random intercepts, is described in Rabe-Hesketh and Skrondal (2005).

$$Logit\left\{Pr\left(V_{iphk}=1\middle|X_{iphk},\zeta_{jk}^{(2)},\zeta_{k}^{(3)}\right)\right\}=\beta 1+\beta_2 x_{2_{iphk}}+\ldots+\beta_n x_{nk}+\zeta_{jk}^{(2)}+\zeta_{k}^{(3)}$$

Where $x_{2_{ijk}},\ldots,x_{n_{ijk}}$ are characteristics of the respondent *i*, of his or her partner *p*, of his or her household *h* living in village *j* located in state *k,* and where $\zeta_{jk}^{(2)}$ and $\zeta_{k}^{(3)}$ are random-intercept terms for level 2 (village) and level 3 (state). The random-intercept terms represent the combined effect of all omitted village-level and state-level unobserved heterogeneity that affects testing behaviour of individuals in some villages and states. The random-intercepts thus represent unobserved heterogeneity in the overall response.

The intraclass correlations (Appendix 4) indicate that 48% of the total residual variance is due to the between-village residual variance and 20% is due to the between-state residual variance in the

[7] This model was found to be superior to a model with only one random intercept at the village level as the LR test for nested model was $chi^2(1)=108.41$, $P<0.01$ in the sample of wives and $chi^2(1)=38.34$, $P<0.01$ in the sample of husbands.

wives sub-sample while slightly lower intraclass correlations are found in the husbands sub-sample, confirming that interdependence in response of the individuals from the same village (Table 2).The higher intraclass correlation found among women may be explained by the fact that ANC services may play an important roles in HIV testing behaviours of women and that information on facilities providing ANC services is missing.

To test multicollinearity, Variance Inflation Factors (VIF) are used. The VIF shows how much the variance of the coefficient estimate is being inflated by multicollinearity. When the squared term of age was excluded, the largest VIF was around 6 and the mean VIF was around 2 in both sub-samples, which does not suggest high multicollinearity.

5. RESULTS

Insert Table 2

Socio-economic determinants

Education is one of the main determinants of knowing HIV status in both sub-samples; respondents with a tertiary educational level are 4.6 and 14.3 percentage points more likely to have been tested than non educated respondents for women and men respectively. Education is thus the main predictor of HIV testing of men; it is also interesting to note that partner's education also increases the likelihood of being tested for men, as men married to women with a tertiary educational level are 6.1 percentage points more likely to have been tested than men married to women with no education. Since women have a low bargaining power on average in the sample, we would have expected to find an effect of the partner's education on their likelihood of being tested but this variable is not found to be statistically significant. One potential explanation could be that, since there is assortative matching in the sample (coefficient correlation of wife's and husband's education is 0.65) and men are on average more educated than women, there is a poor variability in partner's education in the sample of women who have a tertiary educational level. Indeed, 72% of the most educated women have a husband with the highest educational level while this percentage is only 32% in the sample of men.

The wife's and her partner's age has a positive effect on women's HIV testing behaviour as an increase in one year increases the likelihood of being tested by 1.9 percentage points. The squared term suggests that the relationship between age and HIV testing is not linear as after 30.6 years old the likelihood of being tested decreases, note that a similar functional form was found in many

SSA countries in Cremin et al. (2012). Age is however not found to be a predictor of HIV testing in the men sample.

Respondents belonging to wealthier households are also more likely to have been tested, wealth has a stronger effect among women than among men as an increase in one standard deviation in the wealth index increases the likelihood of being tested by 5.4 and 3.1 percentage points in the wives and husbands sub-samples, respectively. Wealth may capture the ease of paying for transport to go to the testing centre since HIV testing is free but also unobserved characteristics associated with the poverty level.

Women's bargaining power is positively associated with HIV testing in the wives' sample, however its effect is lower than one would expect. After controlling for religion and women's bargaining power, it is interesting to note that women in polygamous households are less likely to be tested by 2.3 percentage points. This result could be explained by the fact that resources are scarcer in polygamous households and that the wealth asset is unable to take this into account. Another explanation according to Cartoux et al. (1998) could be that "polygamy increases the complexity of disclosing the results and could increase the risks of dismissal". A final explanation could be that polygamous households have more traditional views and may less be inclined to be tested. Another interesting result is that after controlling for HIV prevalence, stigma, bargaining power and socio-economic factors, Muslim women and men were still found to be less likely to be tested than Catholic respondents by 4.9 and 3.4 percentage points respectively. A similar result was found in Tanzania by de Paoli et al. (2004) and this finding was assumed to be due to polygamy, which is obviously not the right transmission channel in our sample since while controlling for polygamy the dummy *Muslim* is still statistically significant. Alternatively, we think that this could be explained by the fact that Muslims have ideas and social norms negatively affecting HIV testing behaviours. For instance, Muslim societies are found to strongly associate HIV/AIDS to homosexuality, sex outside marriage and drug use and have strong taboos regarding sexual behaviours and sexuality (Remien et al., 2009). Other explanations could be that knowing that they are less likely to be infected, health providers are less likely to offer or prescribe a test to Muslims patients or maybe the Muslim variable captures the fact that Muslims have less risky sexual practices.

Stigma

It is found that persons who stigmatise PLWA are less likely to have been tested as an increase in the stigma score of one standard deviation reduces the likelihood of ever having been tested of wives and husbands by 1.5 percentage points. When the partner stigmatises PLWA it also reduces

the likelihood of being tested but it has a lower effect since an increase in one standard deviation reduces the likelihood of ever having been tested by 0.8 and 0.9 percentage points for women and men respectively. One may want to note that this variable may be endogenous to the HIV status of the respondents as we would expect HIV positive persons to be less likely to stigmatize PLWA.

HIV knowledge

An increase in one point in the HIV knowledge score is found to increase the likelihood of being tested by 1.2 percentage points in the sample of women. It is interesting to note that this effect is low and not statistically significant for husbands. In order to take into account that the effect of HIV knowledge is likely to be stronger among educated individuals, this variable was interacted with the educational level variable. The interaction variable was however not found to be statistically significant in either sub-samples. The low effect of HIV knowledge is probably attributable to the fact that the score does not include questions measuring respondent's knowledge regarding the availability and benefits of treatment. Indeed, it is found that female and male respondents who know the benefits of ART have a greater likelihood of having been tested by 5 and 4.9 percentage points.

Routine testing

Routine testing is a strong determinant of HIV testing for women as firstly; women who had a birth in the last three years have a greater likelihood by 8.6 percentage points of being tested. Secondly, women for whom the absence of female health worker in the facility is not a concern are more likely to have been tested by 4.6 percentage points, which suggests that the absence of female health worker is a barrier to HIV testing. Finally, women who had an STI during the last 12 months have also a greater likelihood of being tested by 5.4 percentage points. Men who had an STI during the last year are more likely to have been tested by 6 percentage points (but note that the p-value is 0.103). Women and men covered by health insurance are more likely to have been tested by 6.7 and 5.6 percentage points respectively, which probably results from a greater frequency of contacts with a health provider. However as stipulated previously, insured may have different characteristics from the rest of the sample and cannot be then considered exogenous.

Health status

Health status does not provide an interesting piece of information since the fact that it is positively correlated to HIV testing may suggest that women who have a better health are the ones who

invest more in their health capital and consequently have a greater willingness to know their HIV status.

Perceived risk

The fact that the partner knows his HIV status positively affects the likelihood of being tested by 4.2 and 3.3 percentage points. This effect is lower than one would expect and is probably due to the fact that some variables affecting the likelihood of partner's testing are included in the estimate. When control variables are removed the fact that the partner is tested increases the likelihood of being tested by 8 and 11 percentage points for women and men respectively. Results also indicate that women who have been married for many years are less likely to have been tested after controlling for their age and partner's age. This may be explained by the fact that those women perceive a lower risk of getting infected. For both partners, knowing someone who has AIDS increases HIV testing by 3.7 and 5.3 percentage points for women and men respectively. This could be explained by the fact that the partner could be the infected person or it could also be explained by the fact that persons who have a HIV positive relative are less likely to stigmatize PLWA. Other measures of perceived risks such as the number of lifetime partners and the HIV prevalence are however not statistically significant in both sub-samples.

6. DISCUSSION AND CONCLUSION

The study has highlighted that the poorest, the less educated, those who stigmatise PLWA and Muslim respondents were less likely to have ever been tested and to have received their test results. In the sample of women, it is found that youngest and oldest women, women married for more than 10 years, traditionalist women, women belonging to polygamous households as well as women who did not visit a health facility either because she had no recent pregnancy, no STI or because they fear that there will not be a female worker in the facility were less likely to be tested.

Effective policies to increase HIV testing would aim to increase the number of female health workers, to invest on education, to inform people about the benefits of ART, to increase testing centre accessibility or home based testing in order to increase access for the poorest. The introduction of financial incentives is also likely to stimulate individuals to learn their HIV status since they may provide a compensation for transport cost, opportunity cost of time and psychological costs associated with learning HIV status but more interestingly monetary incentives could reduce stigma as it may provide a broader reason for going to the testing centre (Thornton, 2008). Given that couple HIV testing prevalence was only 6% while it is around 15% at the

partner's level, HIV testing seems to be an individual decision rather than a decision made jointly by both partners, which is important in the framework of the introduction of PreP because it means that identifying discordant couples could be very arduous and costly. Moreover, such finding requires thinking about the most relevant entry points to target HIV sero-discordant couples, if ANC facilities appear to be an effective option, one needs to think about most cost-effective ways to reach ANC attendees' partner. Additional research regarding the cost-effectiveness of the introduction of financial incentives to reach ANC attendees' partner in comparison to other strategies to target HIV sereo-discordant couples such as for instance home based testing or pre-marital testing would be of a strong interest.

It is interesting to note that although women were expected to have a lower HIV testing prevalence than men due to gender related barriers to care, men and women are found to have the similar HIV testing levels. This result is mostly explained by testing routine during pregnancy. Although routine testing is found to be largely acceptable and effective in diagnosing new HIV cases (Chandisarewa et al., 2007; Creek et al., 2007; Nakanjako et al., 2007; Wanyenze et al., 2008) and necessitates scale up since PMTCT coverage still remains low with only 1,120,178 (16.9%) pregnant women counselled and tested for HIV and receiving their results in 2011 (National Agency for the Control of AIDS, 2012), routine testing is also found to have adverse effects in regions with high stigma and discrimination towards PLWA. In fact, Weiser et al. (2006) have found that "68% (of patients) felt that they could not refuse the HIV test" and if patients feel forced to be tested, routine testing could reduce the frequency of utilization of health facilities. A recent study conducted in Kenya by Janet M. Turan et al. (2012) has shown that as a result of communication campaigns to increase PMTCT often targeting HIV positive women, many women in Kenya associate delivery in health facility use as a service for HIV positive women, and as a result a large percentage of women prefer delivering at home. Thus routine testing scale up policy should be accompanied by policies to reduce stigma.

The study suffers from a few limitations. The first one is that DHS data sets do not include information on health providers' characteristics, thus the effect of the accessibility and the quality of testing services as well as the access to ART in the closest testing centre is unknown. Future research should try to link information on the demand and supply side in order to have a more comprehensive HIV testing model. Another issue is the absence of information regarding the HIV status of the respondent; as a consequence the causal impact of the variables that could have been affected by the HIV status such as stigma and HIV knowledge cannot be examined.

Secondly, data are self-reported and there might be some measurement errors in the dependent variable especially when another person assisted to the interview. In order to see if different results were obtained depending on the presence of other persons to the interview, the analysis was restricted to the sub-sample of women whose husband, other males and other females were absent during the interview. It was found that the prevalence of HIV testing very slightly increases (from 15.32 to 15.40%) and this difference was not statistically significant, justifying the close results obtained. Moreover, it should be noted that there might be a selection bias in that the presence of an adult during the woman's interview may not have been random. Underreported of HIV testing could also have occurred among HIV positive persons. Other limitation resides in the absence of panel data to highlight the determinants of HIV testing over time. And finally that results are based on HIV testing prevalence in 2008 and testing prevalence as well as its determinants may have changed over the last years. DHS data collected in 2003 were used in order to conduct similar analysis. In 2003, HIV testing prevalence was 6% among women and 17% among men. The analysis of the determinants of HIV testing in 2003 indicate that this increase in HIV testing among women is maybe due to an expanded PMTCT programme since the presence of birth in the last three years was not statistically significant in 2003. The main determinants at this time were the presence of a STI and the education level. In contrast, the main determinants of HIV testing in the men sample were the education level, the wealth status and the fact to know someone who is infected or died of AIDS, suggesting that the determinants of men HIV testing may not have varied a lot over time.

This study showed that although 15% of men and women were tested in 2008, only 6% of men and women from the same couple were tested. Moreover, the fact that the spouse knows his (her) HIV status only increases the likelihood of his (her) partner to be tested by 3.2 (4.2) percentage points, suggesting that HIV testing behaviours cannot be considered as a joint decision of spouses. Moreover, the analysis of the determinants of HIV testing of men and women belonging to the same couple are not predicted by the same factors. Reaching sero-discordant couples for the introduction of Prep and TasP is likely to continue to be a challenge without dramatically different approaches to testing. Given the high negative effect of stigma and wealth on HIV testing, the results suggest that financial incentives and or community-based household testing could be an effective way to improve the prevalence of HIV testing in Nigeria.

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Table 1: Descriptive statistics of dependent and independent variables

		Wives				Husbands				
Variables	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max
Know HIV status (%)	*8505*	*0.129*	*0.339*	*0*	*1*	*6773*	*0.142*	*0.35*	*0*	*1*
Socio-economic characteristics										
Ethnicity: Fula (ref: Hausa)	8682	0.286	0.452	0	1	7510	0.271	0.444	0	1
Ethnicity: Igbo	8682	0.086	0.281	0	1	7510	0.096	0.294	0	1
Ethnicity: Ijaw/Izon	8682	0.026	0.159	0	1	7510	0.030	0.171	0	1
Ethnicity: Yoruba	8682	0.125	0.330	0	1	7510	0.141	0.348	0	1
Ethnicity: Other	8682	0.371	0.483	0	1	7510	0.368	0.482	0	1
Religion: Other Christian (ref: Catholic)	8680	0.314	0.464	0	1	7490	0.331	0.471	0	1
Religion: Islam	8680	0.591	0.492	0	1	7490	0.561	0.496	0	1
Religion: Traditionalist	8680	0.020	0.141	0	1	7490	0.019	0.136	0	1
Religion: Other	8680	0.001	0.032	0	1	7490	0.003	0.054	0	1
Education: Primary (ref: No Education)	8731	0.239	0.426	0	1	7521	0.287	0.452	0	1
Education: Secondary	8731	0.114	0.318	0	1	7521	0.179	0.383	0	1
Education: Tertiary	8731	0.060	0.237	0	1	7521	0.123	0.329	0	1
Labour status	8709	0.635	0.481	0	1	7514	0.983	0.128	0	1
Age	8731	29.984	8.360	15	49	7521	38.56	9.452	17	59
Age squared	8731	968.91	531.78	225	2401	7521	1576	752	289	348
Bargaining power	8710	0.007	1.022	-0.49	6.11	7502	0.020	1.019	-0.49	6.1
Sexual bargaining power	8699	0.001	1.001	-1.42	1.63	7492	0.048	0.998	-1.2	1.63
Polygamy	8672	0.328	0.469	0	1	7469	0.221	0.415	0	1
Wealth	8704	-0.004	1.001	-1.36	2.86	7498	0.045	1.022	-1.35	2.86
Household size	8731	6.405	3.390	2	43	7521	5.830	2.941	2	43
Partner's Age	8731	39.157	9.431	17	59	7521	29.87	8.352	15	49
Partner's Labour status	8722	0.985	0.123	0	1	7505	0.647	0.478	0	1
Partner's Education: Primary (ref: No Education)	8731	0.278	0.448	0	1	7521	0.258	0.438	0	1
Partner's Education: Secondary	8731	0.164	0.371	0	1	7521	0.128	0.334	0	1
Partner's Education: Tertiary	8731	0.116	0.321	0	1	7521	0.067	0.251	0	1
HIV related stigma										
Stigma	7223	0.031	1.007	-2.03	1.48	6814	-0.049	1.035	-2.45	1.84
Partner's Stigma	7887	-0.005	1.022	-2.45	1.84	6296	0.004	1.014	-2.02	1.45
HIV Knowledge										
HIV knowledge	8539	4.732	2.572	0	8	7424	5.653	2.243	0	8
Heard of ART	7216	0.512	0.5	0	1	6790	0.676	0.468	0	1
Radio	8693	0.269	0.443	0	1	7489	0.565	0.496	0	1
Routine testing										
STI	8613	0.019	0.135	0	1	7422	0.011	0.105	0	1
Birth in the last 3 years	8731	0.624	0.484	0	1					
State HIV prevalence	8731	3.565	1.980	0.9	8.8	7521	3.559	2.010	0.9	8.8
Absence of female health worker is a concern	8698	0.239	0.420	0	1					
Health insurance	8698	0.016	0.125	0	1	7496	0.030	0.171	0	1
Rural	8731	0.731	0.443	0	1	7521	0.713	0.452	0	1
Health status										
BMI	8469	22.64	4.482	12.46	59.61					
Perceived risk										
Partner has been tested	7870	0.133	0.339	0	1	7296	0.145	0.353	0	1
Knows someone with AIDS	7191	0.127	0.333	0	1	6762	0.218	0.413	0	1
Marital duration:5-9 (ref: 0-4)	8731	0.223	0.417	0	1	7521	0.210	0.407	0	1
Marital duration: 10-19	8731	0.337	0.473	0	1	7521	0.312	0.463	0	1
Marital duration: >20	8731	0.214	0.410	0	1	7521	0.274	0.446	0	1
Number of lifetime partners	8548	1.411	0.926	1	15	6863	3.005	2.591	1	15
State HIV prevalence	8731	3.565	1.980	0.9	8.8	7521	3.559	2.010	0.9	8.8

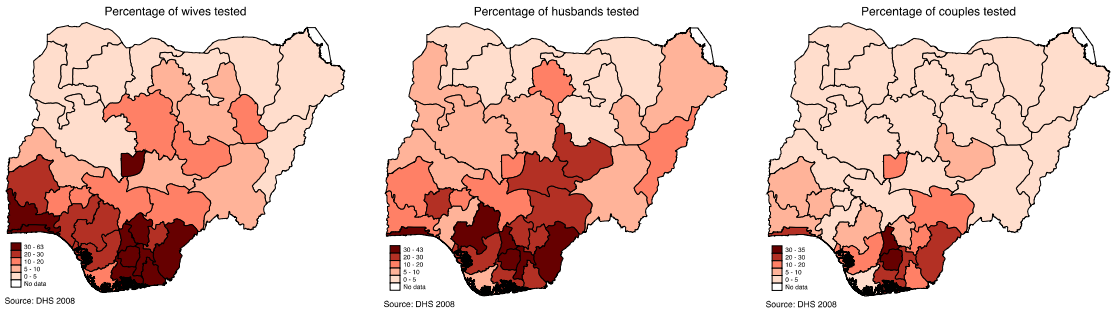
Table 2: Determinants of knowing HIV status among men and women

	Wives (n= 5782)		Husbands (n=4892)	
	ME	SE	ME	SE
Socioeconomic status				
Ethnicity: Fula (ref: Hausa)	-0.027	0.027	-0.020	0.034
Ethnicity: Igbo	0.035	0.032	0.078**	0.037
Ethnicity: Ijaw/Izon	0.006	0.044	-0.045	0.049
Ethnicity: Yoruba	0.020	0.031	0.016	0.036
Ethnicity: Other	0.021	0.026	0.033	0.032
Religion: Other Christian (ref: Catholic)	-0.030**	0.014	-0.014	0.015
Religion: Islam	-0.049***	0.019	-0.034*	0.020
Religion: Traditionalist	-0.152*	0.088	0.008	0.039
Religion: Other	-0.080	0.117	0.124*	0.066
Education: Primary (ref: No Education)	0.005	0.013	0.067***	0.018
Education: Secondary	0.037**	0.015	0.077***	0.019
Education: Tertiary	0.046**	0.020	0.143***	0.021
Labour status	0.006	0.010	-0.041	0.029
Age	0.019***	0.005	-0.006	0.005
Age squared	0.000***	0.000	0.000	0.000
Bargaining power	0.010***	0.004	0.001	0.004
Sexual bargaining power	0.006	0.005	0.001	0.005
Polygamy	-0.023*	0.013	0.021	0.014
Wealth	0.054***	0.007	0.031***	0.007
Household size	-0.002	0.002	0.002	0.002
Partner's age	0.002**	0.001	0.000	0.001
Partner's labour status	-0.037	0.027	-0.004	0.011
Partner's Education: Primary (ref: No Education)	0.010	0.014	0.030**	0.014
Partner's Education: Secondary	0.019	0.016	0.027	0.017
Partner's Education: Tertiary	0.019	0.017	0.061***	0.021
HIV related stigma				
Stigma	-0.015***	0.005	-0.015***	0.005
Partner's stigma	-0.008*	0.005	-0.009*	0.005
HIV Knowledge				
Heard of ART	0.050***	0.010	0.049***	0.013
HIV knowledge	0.012***	0.003	-0.003	0.004
Radio	-0.005	0.009	0.014	0.011
Routine testing				
Absence of female health worker is a concern	-0.046***	0.014		
Birth in the last 3 years	0.086***	0.011	0.001	0.011
STI	0.054**	0.026	0.060	0.036
Has health insurance	0.067***	0.024	0.056***	0.019
Rural	-0.005	0.011	0.010**	0.012
Health status				
BMI	0.000	0.001		
Perceived risk				
Partner has been tested	0.042***	0.010	0.033***	0.011
Knows someone with AIDS	0.037***	0.012	0.053***	0.012
Marital duration: 5-9 years (ref: 0-4 years)	-0.011	0.012	-0.002	0.014
Marital duration: 10-19 years	-0.046***	0.015	0.005	0.016
Number of lifetime partners	-0.003	0.004	0.001	0.002
State HIV prevalence	0.002	0.006	0.003	0.004
$\zeta_{jk}^{(2)}$	0.53	0.09	0.40	0.12
$\zeta_{k}^{(3)}$	0.81	0.13	0.50	0.10

*** p<0.01, ** p<0.05, * p<0.1

(1) LR test vs. logistic regression:$Chi^2(2)=152$, p<0.01 and (2) LR test vs. logistic regression: $Chi^2(2)=43$, p<0.01

Figure 1: Prevalence of HIV testing per state



Appendix 1: Creation of bargaining power indexes

1. Bargaining power index

Categories	Weight	Contribution to index
Final say on own health care		
Respondent alone	3.979	0.254
Respondent and partner	-0.332	0.009
Partner alone	-0.239	0.009
Final say on making large household purchases		
Respondent alone	4.969	0.226
Respondent and partner	-0.319	0.008
Partner alone	-0.122	0.002
Final say on making household purchases for daily		
Respondent alone	2.706	0.22
Respondent and partner	-0.442	0.016
Partner alone	-0.324	0.014
Final say on visits to family or relatives		
Respondent alone	3.287	0.221
Respondent and partner	-0.26	0.007
Partner alone	-0.325	0.013
Percentage explained by dimension	99.25	
Observations	8632	

2. Sexual bargaining power

Categories	Weight	Contribution to index
Can respondent refuse sex		
no	1.2	0.294
yes	-0.857	0.203
Not sure	-0.387	0.003
Can ask partner to use condom		
no	0.821	0.193
yes	-1.378	0.302
Not sure	-0.298	0.005
Percentage explained by dimension	65.64	
Observations	8688	

Appendix 2: Items included in the stigma index

	Women		Men	
Categories	Weight	Contribution to index	Weight	Contribution to index
Willing to care for relative with aids				
no	1.047	0.078	0.837	0.028
yes	-0.574	0.043	-0.212	0.007
Person with aids allowed to continue teaching				
no	1.015	0.098	1.198	0.124
yes	-0.919	0.089	-0.909	0.094
Would buy vegetables from vendor with aids				
no	0.682	0.06	0.954	0.098
yes	-1.233	0.108	-1.105	0.113
People with aids should be ashamed of themselves				
disagree	-1.375	0.154	-1.596	0.181
agree	0.948	0.106	0.879	0.1
People with aids should be blamed for bringing disease to the community				
disagree	-1.389	0.157	-1.597	0.17
agree	0.951	0.107	0.799	0.085
Percentage explained by dimension	83.32		77.08	
Observations	5886		5779	

Appendix 3: Items included in the HIV knowledge index

	Men (%)				Women (%)			
Variables	n	Gave correct answer	Did not know	Gave incorrect answer	n	Gave correct answer	Did not know	Gave incorrect answer
Reduce risk of getting aids by not having sex at all	6,806	84	4	11	7,225	77	8	15
Reduce chances of aids by always using condoms during sex	6,809	70	15	15	7,229	58	24	17
Reduce risk of getting aids if have 1 sex partner with no other partner	6,803	90	5	5	7,220	79	10	11
Drugs to avoid aids transmission to baby during pregnancy	5,082	56	19	25	4,560	52	18	30
Can a healthy person have aids	6,798	83	6	11	7,204	73	11	16
Can get aids by witchcraft or supernatural means	6,809	15	15	70	7,219	17	24	58
Get aids by sharing food with person who has aids	6,812	15	10	75	7,251	16	15	69
Get aids from mosquito bites	6,815	23	14	63	7,241	21	18	61

Appendix 4: Intraclass correlation computation

The random intercepts are shared among individuals in the same village and state. This dependence between individuals belonging to the same cluster is expressed in term of the correlation within a cluster called the intraclass correlation. The different types of intraclass correlations for the latent responses of two individuals V^*_{iphk} and $V^*_{i'phk}$ are measured as follows:

$\varrho(state)=\text{Cor}(V^*_{iphk}, V^*_{i'phk} \mid X_{iphk}, X_{i'phk}) = \psi^{(3)} / (\psi^{(2)}+\psi^{(3)}+(\pi^2/3))$

$\varrho(village, state)=\text{Cor}(V^*_{iphk}, V^*_{i'phk} \mid X_{iphk}, X_{i'phk}) = \psi^{(3)} + \psi^{(2)} / (\psi^{(2)}+\psi^{(3)}+(\pi^2/3))$

where $\psi^{(3)}=1.27$ and $\psi^{(2)}=1.77$ in the wives sample and where $\psi^{(3)}=0.89$ and $\psi^{(2)}=1.18$ in the husbands sample.

Note that $\psi^{(3)}>0$, $\psi^{(2)}>0$ and $\varrho(village, state)>\varrho(state)$ because individuals from the same village are more similar than individuals from the same state.